Peripheral Collisions with STAR

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The STAR detector is preparing to study peripheral collisions, which can occur when the colliding nuclei pass by at moderately large impact parameters, between twice the nuclear radius and several hundred fermi. Then, the nuclei can interact via their electromagnetic fields. These interactions are marked by final states consisting of at most a handful of produced particles.

Two examples of these reactions are two-photon processes[1] and coherent photonuclear interactions[2], whereby a photon from one nucleus interacts with a Pomeron or meson from the other nucleus. Both of the intermediate particles couple coherently to their emitting nuclei, giving these reactions distinctive kinematics. Because of the coherence, the maximum transverse momentum of the final states is of order 50 MeV/c.

This physics will be studied by the STAR peripheral collisions physics working group. The final states of interest typically consist of 2 or 4 charged particles in the TPC with nothing else visible in the detector. The largest backgrounds are incoherent photonuclear interactions, grazing hadronic nuclear collisions and beam gas events. These backgrounds have been studied with Monte Carlo simulation: FRITIOF and VENUS for the hadronic and beam gas backgrounds, and DTUNUC for the photonuclear interactions. Good signal to noise ratios have been obtained for a variety of signals[3].

For STAR, triggering is complicated because of the limited information available in the early stages of the trigger. Without tracking, the event vertex is not known, and beam gas interactions are much more problematic. Also, cosmic ray muons can be a problem. The cosmic ray muon trigger rate has been reduced by adding a timing window to the central trigger barrel, but cosmic rays will remain a non-negligible factor in the trigger.

We have developed algorithms for Levels 0-3 of the STAR trigger that reject most of this background while preserving most of the signals. The levels 0-2 algorithms rely on the central trigger barrel and multi-wire proportional readout of the TPC anode wires. These algorithms select events with 2 or 4 charged particles in the event, with a topology consistent with a small perpendicular momentum; the selection is gradually refined going from level 0 to 2. At level 3, tracking information is available, and most background is rejected with cuts on vertex position, total charge, and perpendicular momentum.

References

[1] J. Nystrand and S. Klein, "Two-Photon Physics in Nucleus-Nucleus Collisions at RHIC, LBNL-42524, nucl-ex/9811007, Nov., 1998, in Proc. Workshop on Photon Interactions and the Photon Structure, Lund, Sweden, Sept., 1998.

[2] S. Klein and J. Nystrand, "Exclusive Vector Meson Production in Relativistic Heavy Ion Collisions," hep-ph/9902259, submitted to Phys. Rev. C.

[3] S. Klein and J. Nystrand, STAR Note 347, June, 1998. Available on the web at http://www.rhic.bnl.gov/star/starlib/doc/www/sno/ice/sn0347.html